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Patentanmeldung Nr. | Patent application No. | Demande de brevet n°

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Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

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p.o.

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(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
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EXCAVATING DEVICE

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EXCAVATING DEVICE

The invention relates to an excavating device for generating a hole in a geological formation.

WO-A-02/34653 shows such a device. The described device uses a jet of fluid under pressure in which abrasive particles are mixed to erode the material of a surface in order to generate a hole in said surface. The jet is placed under an angle relative to the advancement direction of the device in the hole, and is rotatably operated inside the hole in order to create the hole. This is shown to result in a hole with a heap-shaped center part on the bottom of the hole, as a result of the rotation of the abrasive jet.

The device according to the prior art comprises a distance holder in the form of an L-shaped bracket, in order to ensure a pre-determined distance of the nozzle to the bottom of the hole. The bracket contacts the hole bottom surface in the part of the hole bottom surface that diametrically opposed to where the abrasive jet stream impacts the hole at that very moment. This may lead to misalignment of the jet stream, and thereby undesired erosion into the bore hole wall, and a less effective use of the abrasive jet.

The device according to WO-A-02/34653 has the further disadvantage that when the abrasive jet leaves the nozzle outlet it enters a free space and the abrasive jet is not guided along the bottom surface resulting in a less effective use of the energy in the abrasive jet.

It is an object of the invention to increase the effectiveness of the energy present in the abrasive jet.

According to the invention, there is provided an excavating device for generating a hole in a geological formation, which excavating device comprises:

- a body rotatable inside the hole along a rotation axis;
- a nozzle arranged on the body to jet a stream of an abrasive fluid onto a surface in the geological formation in order to generate the hole, wherein the stream has at least an azimuthal velocity component and one parallel to the rotation axis; and
- a distance holder arranged on the body to ensure a predefined distance between the nozzle outlet and the surface; wherein
- the distance holder has a trumpet shaped inner surface section facing the geological formation, which trumpet shaped inner surface section is provided with an opening for allowing the stream to pass through.

The trumpet shaped inner surface section, which more or less matches the heap-shaped bottom profile, provides an improved degree alignment of the hole bottom profile in front of the rotating jet stream. Because the opening is provided in the trumpet shaped inner surface section, the distance holder ensures that further excavating of the hole can only occur if all of the bottom hole area is eroded.

The trumpet shape can be approached by a number of conical shapes, preferably having a concave side contour or an outwardly tapered contour, with outwardly increasing opening angles.

Preferably, the nozzle discharge direction is substantially parallel to the trumpet shaped inner surface of the distance holder. Herewith it is ensured that the profile of the heap-shaped bottom produced by the steam of the abrasive fluid matches the trumpet

shaped inner surface section of the distance holder sufficiently well.

Preferably, the opening is an elongate shaped opening of which the direction of elongation is aligned with the discharge direction of the nozzle. This allows for a small angle of impact between the stream of abrasive fluid and the heap-shaped bottom of the hole.

In a preferred embodiment, the distance holder is provided with a channel, between the nozzle and the opening arranged to guide the stream from the nozzle through the opening in the trumpet shaped inner surface section. Such a channel facilitates the concentration of the stream density.

The inner surface of the distance holder may come in almost full contact with the hole bottom surface. This will close off the jet stream passage and hamper the fluid jet stream. For this reason, it is preferred that at least part of the channel forms a recess in the trumpet shaped inner surface section of the distance holder. As the space between the distance holder and the bottom surface of the hole is limited, the abrasive jet stream herewith better follows the bottom surface and this increases the efficiency of the abrasive jet stream. By having a sufficiently large recess in the trumpet shaped inner surface section in which the nozzle can discharge, a risk of obstruction of the jet stream by a complementary trumpet shaped bottom hole profile is minimal.

In a preferred embodiment the recess largely overlaps with the discharge channel and is shaped such that it allows for some divergence of the jet stream. Preferably, the recess allows for a divergence angle of the stream of at most 30°. To this end, the angle between the recess walls and the walls of the discharge channel should preferably not exceed 15° in order to avoid stalling or

other unnecessary disturbances of the flow of the jet stream through the recess.

Optionally, a deflector is arranged on the trumpet shaped inner surface section, for deflecting at least a part of the abrasive fluid jet. This deflector could for example be arranged at the end of the conical inner surface for deflecting the abrasive fluid jet such that the bore hole will be enlarged in diameter, so the diameter of the bore hole will get larger than drilled with an excavating device according to the invention without a deflector. The deflector can also be used to provide an improved finishing of the hole wall, by deflecting the jet stream in a direction more parallel to the bore hole wall.

Optionally, cutting elements are arranged on the distance holder. Various locations on the distance holder can usefully support a cutting element, including on the trumpet shaped inner surface section and/or the outer surface of the distance holder for supporting the hole making capacity of the excavating tool. Cutting elements on the outer surface can provide a finishing of the bore hole wall. For some sensors, which are run into the hole after the drilling, this might be preferred if a good contact between the bore wall hole and these devices is required.

The invention further relates to a combination of an excavating device as described above, and a separation system for separating abrasive material out of the stream flowing out of the device and recirculating the abrasive material back into the abrasive fluid in the nozzle.

Preferably, the distance holder has an outer surface profile that is essentially peripheral in a lower part and that converges upward toward the body. Herewith a larger space between the bore wall and the excavating device is provided. Due to this larger space, the

velocity of the fluid stream after it impacted with the geological formation is reduced.

This is especially of advantage when the distance holder is used in combination with the separation system, such as the one that is described in WO-A-02/34653 which has a magnetic body to attract magnetic abrasive particles from the abrasive fluid downstream impact with the geological formation. With such a device it is necessary that the magnet in the device attracts the abrasive particles. The lower flow velocity increases the separation effectivity.

In a preferred embodiment of the combination according to the invention, the outer surface of the distance holder is provided with one or more slots for drainage of the abrasive fluid, whereby one of the slots is arranged such that the stream flowing out of the device is directed along the separation system. If the separating device is not positioned concentrically in the bore hole the flow through the slots is hereby directed preferably such that the distance between the fluid flow and the separating device is minimized.

These and other advantages of the invention will be further elucidated by way of example and in conjunction with the accompanying drawings.

Figure 1 schematically shows a cross section of an excavating device according to the invention.

Figures 2A, 2B and 2C show perspective views of a distance holder of a device according to the invention.

Figure 3 shows a schematic cross sectional view for elucidating the angle between the nozzle discharge direction and the inner surface of the distance holder.

Figure 1 shows an excavating device 1 according to the invention. The excavating device 1 is inserted into hole 2 having a wall 3 and a typical trumpet shaped hole bottom surface 4.

In the figures, like reference numerals refer to like parts.

The excavating device 1 has a first fluid channel 5 in which a drilling fluid is transported to a mixing chamber 6 in which abrasive particles are mixed with the fluid and then are ejected through a nozzle 7 in the form of a jet stream of an abrasive fluid. The device 1 further comprises a distance holder 8 for ensuring a predetermined distance between the nozzle outlet 7 and the bottom surface 4. The distance holder has a trumpet shaped inner surface section facing the geological formation, which trumpet shaped inner surface section is provided with an elongate opening 16 for allowing the stream to pass through.

The abrasive jet stream 9, discharging from the nozzle 7 through the discharge channel 15, passes the trumped shaped inner surface section through the opening. The direction of elongation of the opening is aligned with the discharge direction of the nozzle. Therefore, the jet stream passing through the opening 16 strikes along the heap-shaped bottom surface 4 of the hole, thereby abrading this surface 4. At the same time, the excavating tool is rotated in the hole, such that the hole is symmetrically excavated.

The cuttings resulting from the excavating, and the abrasive jet stream 9, are then discharged through a slot 14 in the outer surface of the distance holder 8. The outside surface 10 of the distance holder 8 converges towards the body of the excavating device, such that a larger space is created between the body of the excavating device and the hole wall in which the velocity of the fluid reduces.

In the embodiment of figure 1, the excavating device 1 is provided with a magnetic body 11 for attracting magnetic abrasive particles in the fluid, such

that they are is recirculated back into the mixing chamber 6.

Figures 2A-2C show different views of the distance holder 8. The distance holder is firmly connectable to a jet stream generating tool part by means of connector 17, here provided in the form of a bayonet catch. The distance holder 8 has a trumpet-shaped inner surface 12 and an outer surface 10. Between this inner surface 12 and an outer surface 10 a contact end surface 13 is present. This contact end surface 13 is provided with three slots 14, which are also called junk slots. A different number of junk slots is also possible.

The abrasive fluid stream can flow through these junk slots 14 out of the space between the trumpet shaped inner surface 12 and the heap-shaped bottom surface 4, and cuttings are also removed from this space through the slots 14.

The nozzle 7 discharges via a discharge channel 15 through the opening 16 provided in the trumpet shaped inner surface 12 of the distance holder 8. The discharge channel 15 ensures that the nozzle outlet 7 is never blocked by the heap-shaped bottom surface 4. The shape of the discharge channel 15 and/or the opening 16 may allow for divergence of the jet stream. The divergence angle preferably does not exceed 30° in order to avoid the occurrence of, for instance, stalling of the jet stream. The presence of recess 15 may also avoid that, if bottom hole profile and inner trumpet shaped profile match very well, an insufficient area is left for the jet stream to pass through to the annulus around the distance holder.

With one or more of the features as set out above, the nozzle discharge direction can be kept almost parallel to the trumpet shaped inner surface of the distance holder, such that the hit zone of the abrasive jet covers at least the full radial length of said

trumpet shaped surface. Consequently, the abrasive jet discharge channel through the trumpet shaped inner surface of the distance holder runs from at least the center of the inner surface to at least the full radius of the distance holder. Both the alignment of the discharge channel through the internal profile and the trumpet shape of that internal profile of the distance holder ensure that all of the bottom hole area is exposed to the abrasive water jet stream during one rotation of the jet stream.

In figure 3 a schematic view of the lower end of device 1 according to the invention is shown. The trumpet shaped inner surface 12 of the distance holder 8 is shown and a typical trumpet shaped bottom surface 4. Furthermore the nozzle outlet 7 is shown. The abrasive jet 9 is discharged in a direction substantially parallel to the conical inner surface 12 of the distance holder 8.

On or more of the group consisting of the trumpet-shaped inner surface section 12, the outer surface 10, and the contact end surface 13 can optionally be provided with cutting elements.

In a special embodiment cutting elements are optionally arranged in the forward directed wall of the junk slots 14 in relation to the direction of rotation. The excavating device is rotated and when a junk slot 14 is arranged in the contact surface 13 it is possible that cuttings or particles falling out of the wall of the excavated hole get caught between the junk slot 14 and the bore hole wall 3. This may hamper the rotation of the excavating device 1 or may damage the distance holder 8. By providing cutting elements in the junk slots, these particles could be cut when they get jammed into the junk slot.

C L A I M S

1. Excavating device for generating a hole in a geological formation, which device comprises:
- a body rotatable inside the hole along a rotation axis;
- a nozzle arranged on the body to jet a stream of an abrasive fluid onto a surface in the geological formation in order to generate the hole, wherein the stream has at least an azimuthal velocity component and one parallel to the rotation axis; and
- a distance holder arranged on the body to ensure a predefined distance between the nozzle outlet and the surface; wherein
- the distance holder has a trumpet shaped inner surface section facing the geological formation, which trumpet shaped inner surface section is provided with an opening for allowing the stream to pass through.

2. Excavating device according to claim 1, wherein the nozzle discharge direction is substantially parallel to the trumpet shaped inner surface of the distance holder.

3. The excavating device of claim 1 or 2, wherein the opening is an elongate shaped opening of which the direction of elongation is aligned with the discharge direction of the nozzle.

4. The excavating device of any one of the previous claims, wherein the distance holder is provided with a channel, between the nozzle and the opening arranged to guide the stream from the nozzle through the opening in the trumpet shaped inner surface section.

5. Excavating device according to claim 4, wherein at least part of the channel forms a recess in the trumpet shaped inner surface section of the distance holder.

6. Excavating device according to claim 4 or 5, wherein any of the preceding claims, wherein recess allows for a divergence angle of the stream of at most 30°.

7. Excavating device according to any of the preceding claims, wherein a deflector is arranged on the conical inner surface, for deflecting at least a part of the abrasive fluid jet.

8. Excavating device according to any of the preceding claims, wherein the distance holder has an outer surface profile that is essentially peripheral in a lower part and converges upward toward the rotatable body.

9. Excavating device according to any of the preceding claims, wherein the outer surface is provided with one or more slots for drainage of the abrasive fluid.

10. Excavating device according to claim 9, wherein at least one of the slots is located in the same azimuthal direction as in which the jet stream is directed.

11. Excavating device according to claim 9 or 10, wherein cutting elements are arranged in the slot on a forward facing side in relation to the direction of rotation.

12. Excavating device according to any of the preceding claims, wherein cutting elements are arranged on the trumpet shaped inner surface section and/or the outer surface of the distance holder.

13. Excavating device according to any one of the previous claims, wherein the distance holder comprises a contact end surface arranged between the outer surface and the trumpet shaped inner surface section of the distance holder, for contact with the surface to be drilled.

14. Excavating device according to claim 13, wherein the contact surface comprises at least one of the slots for drainage of the abrasive fluid.

15. Excavating device according to claim 13 or 14, wherein cutting elements are arranged on the contact end surface.

16. Combination of an excavating device according to any of the preceding claims and a separation system for separating abrasive material out of the stream flowing out of the device and recirculating the abrasive material back into the abrasive fluid in the nozzle.

17. Combination of an excavating device according to claim 16 dependent on any one of claims 9 to 15, wherein the slot is arranged such that the stream flowing out of the device is directed along the separation system.

A B S T R A C T

EXCAVATING DEVICE

Excavating device for generating a hole in a geological formation, which device comprises:
- a body rotatable inside the hole along a rotation axis;
- a nozzle arranged on the body to jet a stream of an abrasive fluid onto a surface in the geological formation in order to generate the hole, wherein the stream has at least an azimuthal velocity component and one parallel to the rotation axis; and
- a distance holder arranged on the body to ensure a predefined distance between the nozzle outlet and the surface; wherein
- the distance holder has a trumpet shaped inner surface section facing the geological formation, which trumpet shaped inner surface section is provided with an opening for allowing the stream to pass through.

(Fig. 3)

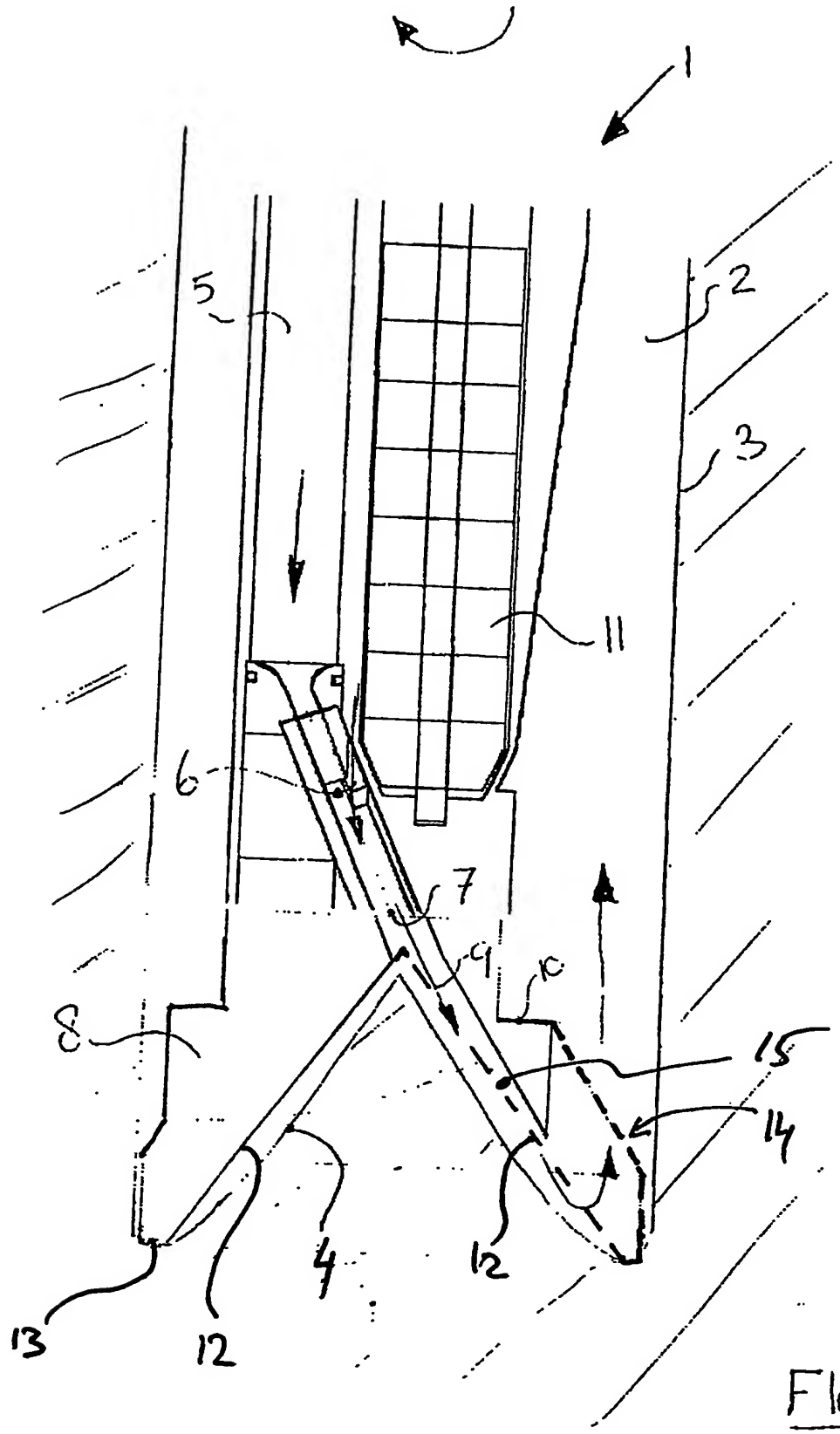

FIG 1

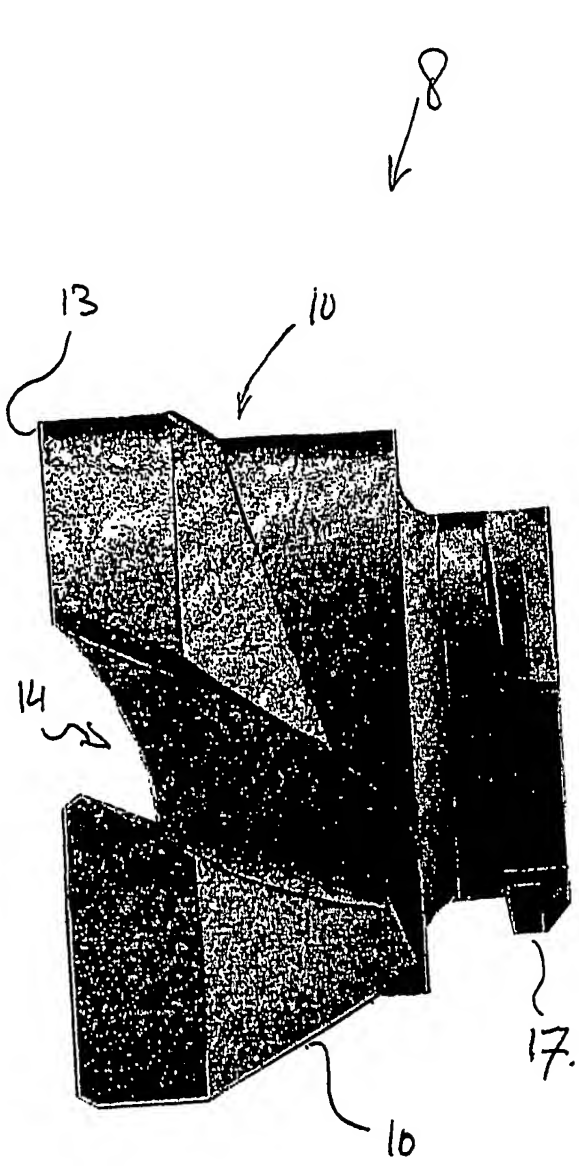

Fig. 2A

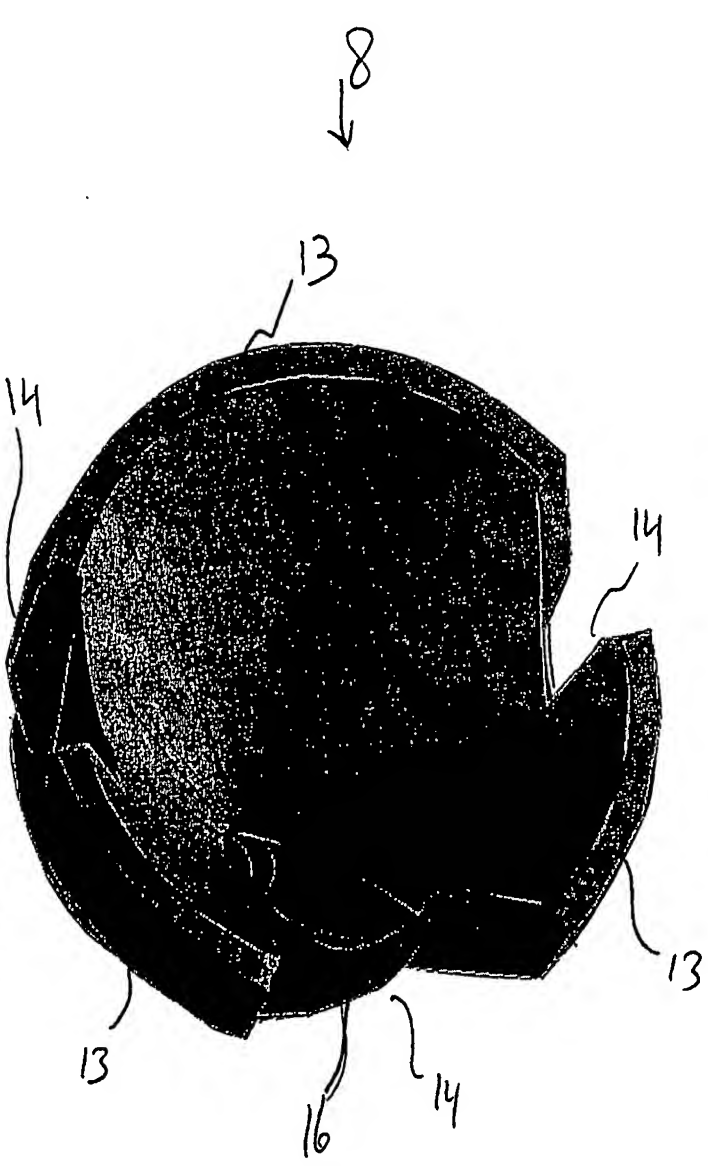

Fig. 2B

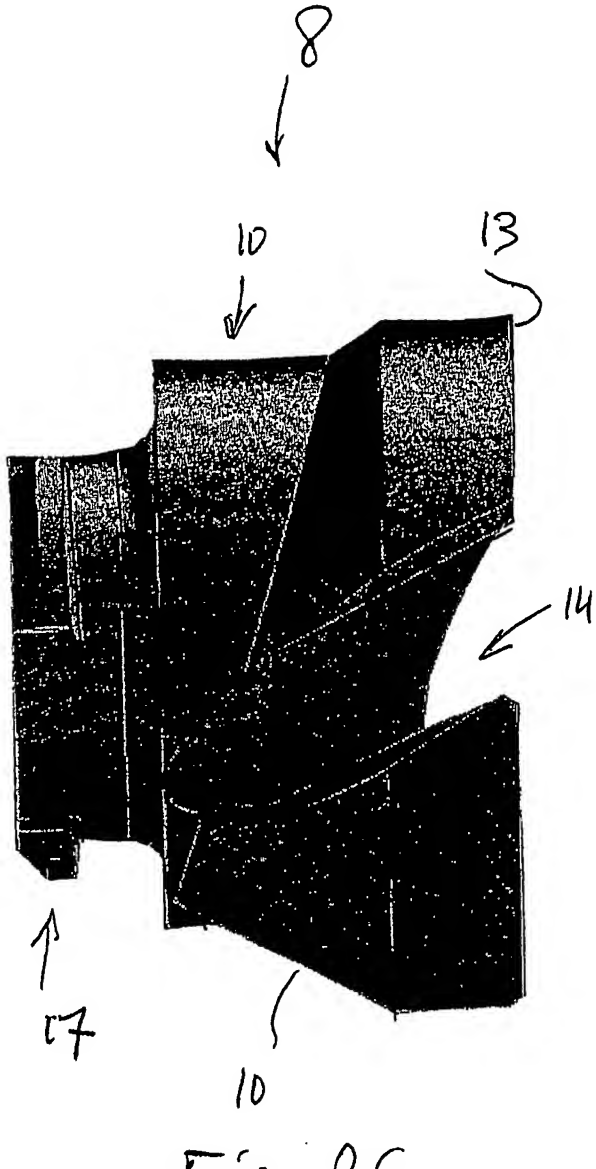

Fig. 2C

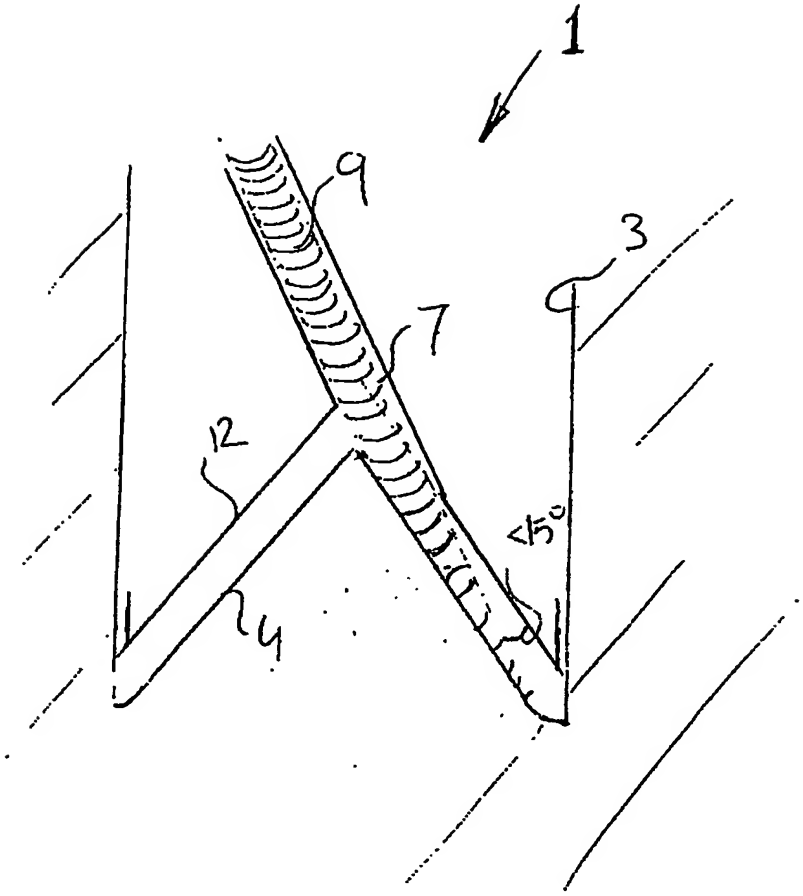

FIG3